AF/1765

Docket No.: 52352-767

PATENT

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6/13/03

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of

Christy Mei-Chu WOO, et al.

Serial No.: 09/826,078 — Group Art Unit: 1765

Filed: April 05, 2001 — Examiner: DEO, Duy, Vu

For: PHYSICAL VAPOR DEPOSITION OF NICKEL

TRANSMITTAL OF APPEAL BRIEF

Mail Stop Appeal
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith in triplicate is Appellant(s) Appeal Brief in support of the Notice of Appeal filed April 10, 2003. Please charge the Appeal Brief fee of $320.00 to Deposit Account 500417.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Appeal Brief is submitted in support of the Notice of Appeal of the final rejection of claims 4, 5, 7, 8 and 10-15, filed April 10, 2003.

I. REAL PARTY IN INTEREST

The real party in interest is ADVANCED MICRO DEVICES, INC.

II. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related appeals and interferences.

III. STATUS OF CLAIMS

Claims 4, 5, 7, 8 and 10-15 are pending in this application, of which claims 4, 5, 7, 8 and 10-15 have been finally rejected. It is from the final rejection of claims 4, 5, 7, 8 and 10-15 that this Appeal has been taken.

IV. STATUS OF AMENDMENTS

No amendment has been filed subsequent to the issuance of the Final Office Action dated October 30, 2002. According to the Advisory Action dated March 25, 2002, the Request for Reconsideration submitted December 16, 2002 was not considered persuasive and, hence, the rejection of claims 4, 5, 7, 8 and 10-15 was maintained.

V. SUMMARY OF THE INVENTION

Fabrication of a semiconductor device and an integrated circuit thereof begins with a semiconductor substrate and employs film formation, ion implantation, photolithographic, etching and deposition techniques to form various structural features in or on a semiconductor substrate to attain individual circuit components which are then interconnected to ultimately form an integrated semiconductor device. As device dimensions and feature size decrease to the deep sub-micron range, performance difficulties escalate, particularly those caused by an increase in the sheet resistance of the contact areas to the source and drain regions and junction leakage as junction layer thickness decreases. To ameliorate the higher electrical resistance caused by shrinking features, the use of self-aligned, highly electrically conductive refractory metal silicides, i.e., "salicides" (derived from Self-ALIgned-siliCIDE), has become commonplace in the manufacture of IC semiconductor devices.

Refractory metals commonly employed in salicide processing include platinum (Pt), titanium (Ti), and cobalt (Co), each of which forms very low resistivity phases with Si, e.g., $PtSi_2$, $TiSi_2$, and $CoSi_2$. Recently, attention has turned towards nickel (Ni) to form nickel silicide utilizing salicide technology. Although the use of Ni in salicide technology has certain advantages over using Ti or Co, there are problems associated with Ni, particularly with the deposition of consistent films of nickel having a low electrical resistance from wafer to wafer. For example, PVD processes used in depositing metal layers are known to have a "first wafer effect" i.e. the physical, chemical and electrical properties of the deposited metal is inconsistent between the first several processed wafers and thus fail to meet acceptable device requirements. First wafer effects results in reduced yields and throughput and poor reliability of silicidation processes and ultimately increases the overall costs thereof.

It has been known that fluctuating chamber hardware conditions results in process inconsistencies which are undesirable for depositing films meeting process specifications and repeatability requirements. To overcome some of these fluctuations, many hardware manufactures advise qualifying the chamber hardware of a deposition tool by heating the chamber under vacuum for a period of time prior to its use in depositing materials on to a semiconductor substrate (i.e., bakeout of the chamber). However, inconsistencies between substrates having a deposited nickel film are still problematic despite qualifying a chamber prior to its use.

The present invention addresses and solves problems related to forming a nickel or nickel alloy layer with high repeatability and consistency by employing the facile method of heating the deposition chamber and/or the substrate during and/or between nickel depositions. It was discovered that by heating the PVD chamber at various stages during the deposition of nickel

over a series of substrates, the first wafer effects were substantially reduce or eliminated and physical and electrical uniformity of the deposited metal films were improved. In particular, it has been shown that by heating the deposition chamber and/or substrate between the introduction and removal of substrates during a continuos nickel deposition process that first wafer effects are substantially reduced.

Claim 8 is presented below with elements read on the specification and drawings, as suggested in MPEP § 1206.

A method of forming nickel layers in a deposition chamber on a plurality of substrates, the deposition chamber having at least one heating element the method comprising:

heating the deposition chamber with the at least one heating element prior to introduction of a first substrate (page 9, lines 24-25);

introducing the first substrate to the deposition chamber while heating the deposition chamber with the at least one heating element (page 5, lines 26-27 and page 9, lines 23-28);

depositing a layer of nickel on the first substrate while heating the deposition chamber with the at least one heating element (page 9, lines 28-30;

removing the first substrate from the deposition chamber while heating the deposition chamber with the at least one heating element (page 9, lines 28-30);

introducing a second substrate to the deposition chamber while heating the deposition chamber with the at least one heating element (page 9, lines 24-30); and

depositing a layer of nickel on the second substrate while heating the deposition chamber with the at least one heating element (page 9, lines 24-30), wherein

the chamber is heated with the at least one heating element continuously between the removal of the first substrate and the introduction of the second substrate (page 9, lines 23-35).

VI. ISSUES

A. The Rejection(s)

Claims 4, 5, 7, 8, 10, 13 and 14 are rejected under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.] (USPN 6,225,202 B1, filed June 21, 2000 and issued on May 1, 2001), admitted prior art, and Wolf [et al.] (SILICON PROCESSING FOR VLSI ERA, VOLUMN 1: PROCESS TECHNOLOGY, 1986, pp. 329-406).

Claims 11 and 12 are rejected under 35 U.S.C. §103(a) as being unpatentable over Gupta [et al.], admitted prior art and Wolf [et al.], as applied to claim 8, and further in view of Chen [et al.] (Comparison of TiSi2, CoSi2, and NiSi for thin-film Silicon-on Insulator Applications, J. Electrochem. Soc., Vol. 144, No. 7, July 1997, pp. 2437-2442).

Claim 15 is rejected under 35 U.S.C. §103(a) as being unpatentable over Gupta [et al.], admitted prior art and Wolf [et al.], as applied to claim 8, and further in view of Kunishima [et al.] (USPN 5,162,263, filed September 6, 1991 and issued on November 10, 1992).

B. Issues

The Issues which arise in this Appeal and requires resolution by the Honorable Board of Patent Appeals and Interferences (Board) is:

i) whether claims 4, 5, 7, 8, 10 and 13 are unpatentable under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.], admitted prior art and Wolf [et al.],

ii) whether claims 11 and 12 are unpatentable under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.], admitted prior art and Wolf [et al.], as applied to claim 8, and further in view of Chen [et al.], and

iii) whether claim 15 is unpatentable under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.], admitted prior art and Wolf [et al.], as applied to claim 8, and further in view of Kunishima [et al.].

VII. GROUPING OF CLAIMS

Claims 4, 5, 7, 8 and 10-15 stand or fall together as a group depending upon the patentability of independent claim 8.

VIII. THE ARGUMENT

Examiner's Position

Regarding the rejection of claim 8 under 35 U.S.C. § 103(a) as being unpatentable over Gupta [et al.], admitted prior art and Wolf [et al.], the Examiner asserts that Gupta [et al.] describes a method of forming nickel silicide comprising introducing the substrate to a deposition chamber, and depositing a nickel layer on the silicon surface by sputtering. The Examiner admits that Gupta [et al] does not describe heating the chamber before introducing the substrate, but relies upon page 2 of the present application as teaching that it is well known to preheat the chamber, including sputtering chamber, to accelerate the removal of contaminates from the chamber, including water vapor and other gases from the chamber components.

The Examiner admits further that "Unlike claimed invention Gupta [et al.] doesn't describe heating the chamber throughout the deposition process. However, it would be obvious to one skilled in the art [to] heat the chamber during deposition in order to keep process temperature constant for the deposition. Also Wolf [et al.] describes the conventional process of sputtering including preheating substrate before deposition heating substrate during deposition. It would have

been obvious for one skilled in the art to deposit nickel also in light of Wolf [et al.] because he teaches that heating substrate during deposition improves film properties such as step coverage (page 361, 367)."

Finally, the Examiner maintains that "Even though Gupta [et al.] doesn't describe the process for a second wafer ... it would be obvious to one skilled in the art that there are more than one wafers being processed at a time. Since it is desired to preheat the wafer before deposition as taught by Wolf [et al.] for a sputtering process it would be obvious to keep the chamber heated in order to heat the second coming wafer and [sic] remain the continuous of the whole process. This would save processing time of reheating the chamber and it would increase product yield."

Appellants Position

The initial burden of establishing a ***prima facie*** basis to deny patentability to a claimed invention is always upon the Examiner. ***In re Oetiker***, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992); ***In re Piasecki***, 745 F.2d 1468, 223 USPQ 785 (Fed. Cir. 1984). In rejecting a claim under 35 U.S.C. § 103, the Examiner must provide a factual basis to support the obviousness conclusion. ***In re Warner***, 379 F.2d 1011, 154 USPQ 173 (CCPA 1967); ***In re Lunsford***, 357 F.2d 385, 148 USPQ 721 (CCPA 1966); ***In re Freed***, 425 F.2d 785, 165 USPQ 570 (CCPA 1970). Based upon the objective evidence of record, the Examiner is required to make the factual inquiries mandated by ***Graham v. John Deere Co.***, 86 S.Ct. 684, 383 U.S. 117, 148 USPQ 459, 469 (1966). The Examiner is also required to explain how and why one having ordinary skill in the art would have been led to modify an applied reference and/or to combine applied references to arrive at the claimed invention. ***Uniroyal, Inc. v. Rudkin-Wiley Corp.***, 837 F.2d 1044, 5 USPQ2d 1434 (Fed. Cir. 1988).

As to Wolf [et al.], it is noted that the preheating referred to in this reference (page 361) is carried out in a separate ***pre-processing chamber***, and when preheating of the wafer is to improve step coverage during deposition, this "may be done in the sputter chamber ***during deposition***". Thus, Wolf [et al.] teaches using a separate pre-processing chamber for preheating, or performs preheating of a wafer "during deposition" process in order to improve step cover of the deposition process.

However, claim 8 requires, *inter alia*:

> heating the deposition chamber with the at least one heating element prior to introduction of a first substrate;
> introducing the first substrate to the deposition chamber while heating the deposition chamber with the at least one heating element;
> depositing a layer of nickel on the first substrate while heating the deposition chamber with the at least one heating element;
> removing the first substrate from the deposition chamber while heating the deposition chamber with the at least one heating element;
> introducing a second substrate to the deposition chamber while heating the deposition chamber with the at least one heating element; and
> depositing a layer of nickel on the second substrate while heating the deposition chamber with the at least one heating element, wherein
> ***the chamber is heated*** with the at least one heating element ***continuously between the removal of the first substrate and the introduction of the second substrate***. (Emphasis added)

The fact that Wolf [et al.] teaches performing preheating of a wafer "during deposition" process in order to improve step cover of the deposition process in no way suggests that the deposition chamber is ***continuously heated between the removal of the first substrate and the introduction of the second substrate***. More specifically, there is nothing in any of the applied prior art references which discloses or suggests any reason to provide this continuous heating of the deposition chamber while one substrate is removed and another is being introduced. Given the disclosures of the references, it would reasonably be presumed that heating of the chamber

ceases when the processing of a wafer is complete and the wafer is to be exited from the chamber, and that the heating of the chamber remains off until a new wafer enters whereupon, the chamber is closed and heating, including preheating, begins anew. The continuous heating of the deposition chamber while one substrate is removed and another is being introduced is what is taught in the present application, not the prior art.

It should be recognized that the fact that the prior art could be modified so as to result in the combination defined by the claims at bar would not have made the modification obvious unless the prior art suggests the desirability of the modification. ***In re Deminski***, 796 F.2d 436, 230 USPQ 313 (Fed. Cir. 1986).

Recognizing, after the fact, that such a modification would provide an improvement or advantage, without suggestion thereof by the prior art, rather than dictating a conclusion of obviousness, is an indication of improper application of hindsight considerations. Simplicity and hindsight are not proper criteria for resolving obviousness. ***In re Warner***, ***supra***.

Page 2 of the present specification merely teaches preheating the chamber under vacuum for a period of time prior to its use in depositing materials onto a semiconductor substrate to remove contaminants from the chamber (i.e., bakeout of the chamber). Given the fact that the chamber needs to be under vacuum, it cannot be said that this is also a teaching of heating the chamber between the exiting of one substrate (or group/batch) and the entry of the next substrate (or group/batch) as there would be no vacuum at such time in the chamber.

Appellants would stress that the requisite motivation to support the ultimate legal conclusion of obviousness under 35 U.S.C. § 103 is not an abstract concept, but must stem from the applied prior art as a whole and have realistically impelled one having ordinary skill in the art

to modify a specific reference in a specific manner to arrive at a specifically-claimed invention. ***In re Newell***, 891 F.2d 899, 13 USPQ2d 1248 (Fed. Cir. 1989).

Generalizations are legally insufficient to establish the requisite motivation. ***In re Deuel***, 51 F.3d 1552, 34 USPQ2d 1210 (Fed. Cir. 1995). However, only generalizations have been used by the Examiner to establish the requisite motivation since no specific teaching of continuously heating of the deposition chamber while one substrate is removed and another is being introduced has been introduced by the Examiner.

Appellants wish to note that reliance upon mere opinion to reject claims is not objective evidence that claims 8, as a whole, is obvious within the meaning of 35 U.S.C. § 103. The inappropriateness of (the Examiner/Board) merely asserting something to be "known in the art" without supporting evidence was decided by the Federal Circuit in the case of ***In re Zurko***, 258 F.3d 1379, 59 USPQ2d 1693 (Fed. Cir. 2001), overturning a decision of the Board of Patent Appeals and Interferences. Further supporting evidence that the Federal Circuit requires evidence of record, not opinion by the Examiner (or Board), can be found in case of ***In re Lee***, 277 F.3d 1338, 61 USPQ2d 1430 (Fed. Cir. 2002).

Clearly, the finding by the Examiner that claim 8 is obvious within the meaning of 35 U.S.C. § 103, is not based on any evidence in the record and, therefore, lacks substantial evidence support.

It is quite telling that after being ***challenged*** to provide evidence that the prior art recognizes continuous heating of the deposition chamber while one substrate is removed and another is being introduced, the Examiner fails to do so, continuing to rely upon opinion rubric. Clearly, the failure of the Examiner to provide objective evidence that this is known in the prior art is a

potent indicium of nonobviousness of this feature of the present invention that, unfortunately, has apparently escaped the Examiner's consideration.

In view of the above, the failure of the Examiner to provide objective evidence that continuously heating a deposition chamber between the exiting of a first substrate (or group/batch) and the entry of the next substrate (or group/batch) is known in the prior art, the present rejection is an example of improper hindsight reconstruction of the claimed invention, which does not support a ***prima facie*** case of obviousness under 35 U.S.C. § 103.

Conclusion

It should, therefore, be apparent that the Examiner did not establish a *prima facie* basis to deny patentability to the claimed invention for want of the requisite realistic motivational element and/or for want of the requisite factual basis. Moreover, upon giving due consideration to both the clear **teachings** of the applied prior art references, and the lack thereof, the conclusion appears inescapable that one having ordinary skill in the art would **not** have found the claimed invention **as a whole** obvious within the meaning of 35 U.S.C. § 103.

Based upon the foregoing, Appellants, therefore, submit that the imposed rejection of independent claim 8 under 35 U.S.C. § 103 as being unpatentable over Gupta [et al.], admitted prior art, and Wolf [et al.] should not be sustained as the Examiner has not established a *prima facie* case of obviousness.

IX. PRAYER FOR RELIEF

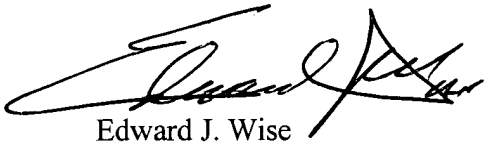
Based upon the above arguments, Appellants, respectfully submit that one having ordinary skill in the art would not have found the claimed invention as a whole obvious within

the meaning of 35 U.S.C. § 103. Appellants, therefore, respectfully solicit the Honorable Board to reverse the Examiner's rejection of claims 4, 5, 7, 8, 10 and 13 under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.], admitted prior art, and Wolf [et al.], of claims 11 and 12 under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.], admitted prior art and Wolf [et al.], as applied to claim 8, and further in view of Chen [et al.], and of claim 15 under 35 U.S.C. § 103 for obviousness predicated upon Gupta [et al.], admitted prior art and Wolf [et al.], as applied to claim 8, and further in view of Kunishima [et al.].

To the extent necessary, a petition for an extension of time under 37 CFR § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY



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APPENDIX

4. (Previously Amended) The method according to claim 8, wherein the at least one heating element comprises a lamp.

5. (Previously Amended) The method according to claim 4, further comprising powering the at least one lamp from about 2 Amp to about 7 Amps during the introduction of both of the first and second substrates to the deposition chamber and during deposition of the nickel layer.

7. (Previously Amended) The method according to claim 8, wherein each substrate comprises silicon and the deposited nickel layer is heated to form a nickel silicide layer.

8. (Previously Amended) A method of forming nickel layers in a deposition chamber on a plurality of substrates, the deposition chamber having at least one heating element the method comprising:

heating the deposition chamber with the at least one heating element prior to introduction of a first substrate;

introducing the first substrate to the deposition chamber while heating the deposition chamber with the at least one heating element;

depositing a layer of nickel on the first substrate while heating the deposition chamber with the at least one heating element;

removing the first substrate from the deposition chamber while heating the deposition chamber with the at least one heating element;

introducing a second substrate to the deposition chamber while heating the deposition chamber with the at least one heating element; and

depositing a layer of nickel on the second substrate while heating the deposition chamber with the at least one heating element, wherein

the chamber is heated with the at least one heating element continuously between the removal of the first substrate and the introduction of the second substrate.

10. (Previously Amended) The method according to claim 8, further comprising cleaning each substrate prior to depositing the layer of nickel.

11. (Previously Amended) The method according to claim 8, wherein the layer of nickel is formed on exposed silicon surfaces of each substrate and the method further comprising:

heating the layer of nickel at a temperature of approximately 300 °C to approximately 550 °C to form a nickel silicide layer.

12. (Previously Amended) The method according to claim 11, wherein the heating of the layer of nickel to form the nickel silicide layer is carried out for approximately 5 seconds to approximately 2 minute.

13. (Previously Amended) The method according to claim 12, further comprising removing unreacted nickel by wet chemical etching.

14. (Previously Amended) The method according to claim 13, wherein the removing unreacted nickel is carried by immersing each substrate in a solution of NH_4OH, H_2O_2 and water or immersing each substrate in a solution of H_2SO_4, H_2O_2 and water.

15. (Previously Amended) The method according to claim 14, further comprising forming a conductive connection to the nickel silicide layers without using a cap layer.